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(71) Applicant: **VOLVO CAR SINT-TRUIDEN,**  
**naamloze vennootschap**  
**Rellestraat 2**  
**B-3800 Sint-Truiden(BE)**

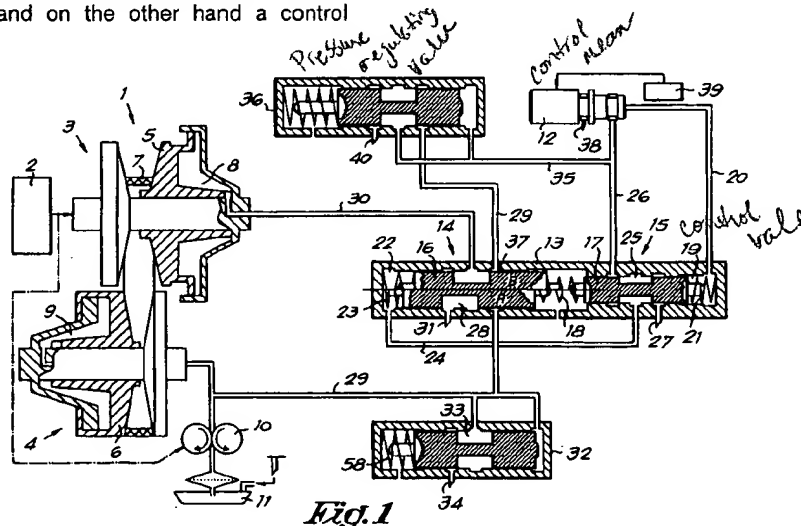
(72) Inventor: **Reniers, Dirk Louis**  
**Koetsweg 33/21**  
**B-3200 Leuven(BE)**

(74) Representative: **Donné, Eddy**  
**Bureau M.F.J. Bockstael nv Arenbergstraat**  
**13**  
**B-2000 Antwerpen(BE)**

(54) **Control device for a continuously variable transmission in a motor vehicle.**

(57) Device for the regulation of a continuously variable transmission in motor vehicles, characterized in that it mainly consists of means for the supply of a hydraulic medium under pressure; control means for the regulation of a pressure; and a controller (13) formed of on the one hand a main valve (14) for the supply and discharge of the hydraulic medium to the regulating cylinder (8) of the continuously variable transmission (1), and on the other hand a control

valve (15), whereby the valve bodies (16, 17) of the main valve (14) and the control valve (15) cooperate by means of elastic means, whereby the valve body (16) of the main valve (14) is loaded by a pressure regulated by the control valve (15) and whereby the valve body (17) of the control valve (15) is loaded by a pressure set by means of the above-mentioned control valves.



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The present invention concerns a device for the regulation of a continuously variable transmission in motor vehicles.

As is known, continuously variable transmissions consist of two V-shaped pulleys in between which a V-belt has been applied. Both pulleys are hereby formed of two cone-shaped pulley halves which can move in relation to one another, such that the transmission ratio can be altered by axially shifting the pulley halves of at least one of said pulleys either more or less apart, as a result of which the radius of the belt is altered. The mutual position of the pulley halves is adjusted as a function of different data by means of hydraulic regulating means, controlled by electronically driven control valves, which provide for the moving of one of the pulley halves.

In order to make the continuously variable transmission work smoothly, it is desirable that the movement of the valve body of the main valve for the supply and discharge of the hydraulic medium to the regulating cylinder of the continuously variable transmission is regulated by means of a control valve. Embodiments are known in which the valve body of said control valve is electromagnetically driven. These devices are disadvantageous however in that they are relatively complicated and expensive.

The present invention concerns a device for the regulation of a continuously variable transmission which does not have said disadvantage.

In particular, the present invention aims a device in which the above-mentioned main valve and control valve have an exclusively hydraulic character, whereby use can be made of conventional valves.

To this end the invention concerns a device for the regulation of a continuously variable transmission in motor vehicles, characterized in that it mainly consists of means for the supply of a hydraulic medium under pressure; control means for the regulation of said pressure; and a controller formed of on the one hand a main valve for the supply and discharge of the hydraulic medium to the regulating cylinder of the continuously variable transmission, and on the other hand a control valve, whereby the valve bodies of the main valve and the control valve cooperate by means of elastic means, whereby the valve body of the main valve is loaded by a pressure regulated by the control valve and whereby the valve body of the control valve is loaded by a pressure set by means of the above-mentioned control valves.

In the preferred embodiment the valve body of the control valve is loaded on one side by the force of a compression spring directly supported by the main valve and on the other side by the force of a spring and by a pressure regulated by means of a

control valve or servo valve, whereas the valve body of the main valve is loaded on one side by the force of the above-mentioned compression spring which is supported by the control valve, and on the other side by the force of a spring and a pressure regulated by means of the control valve.

In a special embodiment means have been integrated in the controller which, when the control valve fails, provide for such a regulation that an intermediate position of the pulleys of the continuously variable transmission is geared to, such that one can always drive with a fixed transmission ratio.

In order to better explain the characteristics according to the invention, the following preferred embodiments are described as an example only and without being limitative in any way with reference to the accompanying drawings, where:

figure 1 shows a device according to the invention;

figure 2 shows a variant according to the invention;

figure 3 shows another variant.

Figure 1 provides a schematic view of a continuously variable transmission 1, driven by an engine 2. This continuously variable transmission 1 consists as is known of two V-shaped pulleys 3 and 4, each with an axially moveable pulley half 5 and 6, which are coupled by means of a transmission belt 7. The pulley halves 5 and 6 can hereby be moved by means of hydraulic cylinders 8 and 9, whereby the effective diameter of the cylinder 8 is bigger than that of the cylinder 9, such that the cylinder 8 functions as a regulating cylinder.

According to the present invention the continuously variable transmission is regulated by means of a device which consists of means for the supply of a hydraulic medium under pressure, for example a pump 10 driven by the engine 2 which pumps up the hydraulic medium from a reservoir 11; control means such as an electronically driven control valve 12; and a controller 13 formed of, on the one hand, a main valve 14 for the supply and discharge of the hydraulic medium to the regulating cylinder 8, and on the other hand a control valve 15, whereby the valve bodies 16 and 17 of the main valve 14 and the control valve 15 cooperate by means of elastic means, such as a spring 18, whereby the valve body 16 of the main valve 14 is loaded by a pressure regulated by the control valve 15 and whereby the valve body 17 of the control valve 15 is loaded by a pressure set by means of the control valve 12.

Hereby, a room 19 has been provided at one side of the valve body 17 which is connected to the outlet of the control valve 12 via a pipe 20, whereby a spring 21 has been provided in this room 19 which also exerts a force on the valve body 17.

On the other side, this valve body 17 is directly supported by the valve body 16 of the main valve 14 by means of the above-mentioned spring 18.

At the side of the valve body 16, situated opposite the side on which said spring 18 exerts its force, a room 22 has been provided in which a spring 23 has also been applied which exerts a force on the valve body 16 opposed to the force of the spring 18. The pressure in the room 22 is regulated via a pipe 24 by means of a port 25 in the valve body 17 of the control valve 15. The port 25 allows for fluid to be either supplied to the room 22 from a supply pipe 26, or to be discharged from the room 22 via a discharge pipe 27.

The springs 18, 21 and 23 are compression springs.

The valve body 16 of the main valve 14 has a port 28 which allows for fluid to be supplied via a pipe 30 from a supply pipe 29 to the regulating cylinder 8 of the continuously variable transmission 1, or for fluid to be discharged via a discharge pipe 31 from the regulating cylinder 8.

The pressure of the fluid supplied by the pump 10 is regulated by an overflow valve 32 which is connected to the above-mentioned supply pipe 29. This pressure is equal to the pressure in cylinder 9 and may be regulated. All the excessive fluid is discharged via a port 33 to a discharge pipe 34.

The control valve 12 is fed via a pipe 35 in which a constant pressure is set by means of a pressure regulating valve 36. The above-mentioned supply pipe 26 is connected to the pipe 35.

It should be noted that the supply pipe 29 goes freely through the controller 13 via a groove 37 provided in the wall.

The control valve 12 regulates the pressure in the room 19 by either supplying fluid from the pipe 35 to the pipe 20, or by discharging fluid from the room 19 and the pipe 20 via a discharge pipe 38. The control valve 12 is in preference driven electronically by means of a control unit 39 which emits signals as a function of different measurements and parameters, such as for example the transmission ratio of the continuously variable transmission 1, the engine speed, etc.

All discharge pipes 27, 31, 34, 38 and the discharge pipe 40 of the pressure regulating valve 36 are connected to the reservoir 11.

The working of the device according to figure 1 is described hereafter.

In the state of rest the valve body 16 of the main valve 14 is in the indicated position A. While driving, the pressure in the room 19 is regulated as a function of the above-mentioned measurements and parameters. At each pressure in the room 19 the valve body 16 takes such a position that the force of the spring 18 is in balance with the force exerted by the fluid pressure in the room 22 as

well as by the spring 23.

As the transmission ratio is changed, the valve body 16 of the main valve 14 is in such a position, indicated by B, that the port 28 forms an intersection with the supply pipe 29 and the discharge pipe 31.

When a higher pressure is set in the room 19, the valve body 17 of the control valve 15 moves somewhat to the left, as a result of which fluid can run from the pipe 26 via the port 25 to the pipe 24 and the pressure in the room 22 rises. This has for a result that the valve body 16 moves to the right as a result of which the spring 18 is compressed more such that the increased force of the valve body 17 as a result of the pressure rise in the room 19 is compensated. A pressure rise in the room 19 thus results in a movement of the valve body 16 to the right, just as a pressure drop in the room 19 causes a movement of the valve body 16 to the left.

If the pressure in the room 19 is low, the pressure in the room 22 will be low as well and the regulating cylinder 8 will be connected via the pipe 30 and the port 28 to the discharge pipe 31. Thus a small radius of the transmission belt 7 around the primary pulley 3 is obtained.

If the pressure in the room 19 exceeds a certain value, the port 28 will connect the pipe 30 to the supply pipe 29. As a result, fluid is supplied and the radius around the primary pulley 3 increases.

It should be noted that the valve body 17 hardly moves, since the changes of pressure at the side of the room 19 are almost immediately compensated by a change of the force in the spring 18. Thus, a very precise regulation without a noticeable time delay is possible.

Figure 2 shows a variant in which the same parts are indicated with the same references.

The embodiment according to figure 2 is special in that means have been integrated in the controller 13 which make it possible for the transmission ratio of the continuously variable transmission 1 to be automatically set at a fixed value when the control means, in this case the control valve 12, fail, in preference halfway between the minimum and maximum transmission ratio, such that one can still drive the vehicle, be it in a less comfortable way.

As shown in the figure 2, these means mainly consist of a switch valve 41, as well as a connection between the moveable pulley half 5 of the primary pulley 3 and the valve body 16 of the main valve 14.

The above-mentioned spring 23 is hereby supported by an element such as a bush 42. The bush 42 is mechanically connected to a tracer finger 43 on the pulley half 5, one and other such that the

spring 23 is compressed by means of the bush 42 as the radius of the primary pulley 3 is reduced. Thus, the spring force depends on the transmission ratio.

Along the side of the valve body 16 opposite the side on which the spring 18 acts two rooms 44 and 45 are formed now, whereby these rooms fulfil the same function as the room 22 in the embodiment in figure 1. Both rooms 44 and 45 allow for separate forces to be exerted on the valve body 16. The rooms 44 and 45 are hereby separated by a bush 46 which consists of a hollow cylinder with a recess 47 and which is kept in place by means of a pin or ball 48 which has been applied in the wall of the controller.

The switch valve 41 has a valve body 49 which is loaded on the one hand by a spring 50 and on the other hand by a pressure in a room 51 which is connected via a pipe 52 to room 19. In the embodiment in figure 2 it is assumed that the control valve 12 is of the type in which, when this control valve 12 fails, the same pressure is set at the outlet as at the inlet. The spring tension of the spring 50 is selected as such in this case that the valve body 49 cannot move against the force of the spring 50 under normal working conditions, but can only move when the pressure in the room 19 is maximal, in other words, when the pressures in the pipes 20 and 35 become equal. As a result, the latter only happens when the control valve 12, in particular the electronics driving the control valve, fail.

Thus, under normal working conditions the valve body 49 is always in the indicated position C. The valve body 49 hereby has a port 53 which in this position C connects the room 45 to the port 25 via pipes 54 and 55. When the control valve 12 fails, the valve body 49 takes the indicated position D, whereby the pipe 55 is closed off and the pipe 54 is connected to a discharge pipe 56 via the port 53.

The working of the device according to figure 2 is mainly as described hereafter.

At each pressure in the room 19, the valve body 16 takes such a position that the force of the spring 18 is in balance with the force of the spring 23 and the forces exerted by the fluid pressures in the rooms 44 and 45. When the pressure in the room 19 rises, the valve body 17 moves somewhat to the left, as a result of which fluid can flow from the pipe 35 via the pipe 26 and the port 25 to the pipes 24, 54 and 55, as a result of which the pressure in the rooms 44 and 45 rises. This has for a result that the valve body 16 moves to the right, as a result of which the spring 18 is compressed much more, such that the increased force on the valve body 17 is compensated as a result of the pressure rise in the room 19. A pressure rise in the

room 19 in this case also causes a movement of the valve body 16 of the main valve 14 to the right, just as a pressure drop in the room 19 causes a movement of the valve body 16 to the left. The valve body 17 of the control valve 15 hardly moves in the meantime.

When the pressure in the room 19 is low, the pressure in the rooms 44 and 45 is low as well, and the regulating cylinder 8 of the continuously variable transmission 1 is connected via the port 28 to the discharge pipe 31. Thus, a small radius is obtained on the pulley 3. The tracer finger 43 pushes the bush 42 maximally to the right, such that the force of the spring 23 is maximal.

As a higher pressure is set in the room 19, the pressure in the rooms 44 and 45 also increases, and the valve body 16 moves more to the right. As soon as the pressure in the room 19 exceeds a certain value, the port 28 connects the pipe 30 and the regulating cylinder 8 to the supply line 29, as a result of which fluid is supplied and the radius of the transmission belt 7 around the primary pulley 3 increases. The bush 42 moves to the left under the influence of the tracer finger 43, as a result of which the force of the spring 23 decreases. This decreased force is compensated by the increase of pressure in the rooms 44 and 45. In this way, the transmission can be engaged.

As the pressure in the room 19 further increases, the valve body 16 moves further to the right, as a result of which the pressures in the pipes 29 and 30 become equal. The radius of the transmission belt 7 around the primary pulley 3 is hereby maximal, whereas that around the secondary pulley 4 is minimal.

When the control unit 39 fails, the control valve 12 makes an open connection between the pipes 20 and 35, and the pressure in the room 19 becomes maximal. Also the pressure in the room 44 becomes maximal, as this is connected to the supply pipe 26 via the port 25 and the pipe 24. Since the valve body 49 moves to the left under the influence of the high pressure in the room 51, the pressure in the room 45 ceases to exist, in particular because the port 53 connects the pipe 54 to the discharge pipe 56.

If the transmission stands in the drive-off position at the time of failure, in particular in the indicated position X, whereby the primary radius is the smallest, the spring 23 pushed in by the bush 42 will move the valve body 16 somewhat to the right until the port 28 makes a connection between the pipe 30 and the supply pipe 29. The transmission 1 thus starts to gear up, such that the bush 42 is moved to the left and the force of the spring 23 decreases. The whole reaches an equilibrium at one particular force of the spring 23, i.e. at one particular transmission ratio. The characteristics of

the spring 23 are hereby selected such that the equilibrium is obtained in an intermediate position Y which is situated about halfway between the lowest position X and the highest position Z.

If the transmission stands in the position Z ("overdrive") at the time of failure, i.e. whereby the primary radius is maximal, the spring 23 will make sure that the transmission 1 gears down until the same equilibrium in the position Y is obtained.

It should be noted that when the electronics fail in the case of the embodiment according to figure 1, the transmission automatically gears up to the position in which the transmission belt 7 has the largest primary radius.

As shown in figure 2 a bush 57 can also be provided in the overflow valve 32, which is connected to the tracer finger 43 and upon which the spring 58 of the overflow valve 32 relies. Thus is obtained that when the transmission ratio increases, the pressure in the supply pipe 29 rises and a higher tensile force is realized on the transmission belt 7, whereas the pressure and thus also the tensile force decrease when the transmission ratio drops.

It is clear that the connection between the pulley 3, in particular the tracer finger 43 and the bushes 42 and 57 does not necessarily need to consist of a direct mechanical coupling. For the tracer finger 43 could also generate a signal which provides in the movement of the bush 42 and/or 57 in one way or another. The tracer finger 43 may also be mounted on the pulley half 6 of the pulley 4.

It is clear that the invention can also be realized in other embodiments and that it does not depend on the type of control means. In figure 3, for example, a variant of the device according to the invention is shown in which it is assumed that the control valve 12 is of the type whereby, when this control valve 12 fails and/or when the electronics driving this control valve 12 fail, the outlet becomes pressureless. The means which allow for the transmission ratio to be set at a fixed value hereby consist of a switch valve 41 which is made such and connected in such a way that when the control means fail any of the above-mentioned rooms is connected to a pipe under constant pressure, for example the pipe 26.

To this end the pipe 55 in this embodiment is connected to the pipe 26 instead of to the pipe 24, and the discharge pipe 56 from figure 2 is replaced by a pipe 59 which is connected to said pipe 24. The spring tension of the spring 50 is selected such in this case that under normal working conditions the valve body 49 stands in position D, and in position C when the control valve 12 fails. To this end, the spring tension is selected such that the valve body 49 is moved to the left at the

slightest pressure in the room 51.

Under normal working conditions, i.e. in position D, the room 45 is then connected to the pipe 24 via the port 53, whereby when the control valve 12 fails, i.e. in position C, the room 45 is connected to the pipe 26 via the port 53.

The present invention is in no way limited to the embodiments described by way of example and shown in the accompanying drawings; on the contrary, such a device for the regulation of a continuously variable transmission in motor vehicles can be made in all sorts of variants while still remaining within the scope of the invention.

## Claims

1. Device for the regulation of a continuously variable transmission in motor vehicles, characterized in that it mainly consists of means for the supply of a hydraulic medium under pressure; control means for the regulation of said a pressure; and a controller (13) formed of, on the one hand, a main valve (14) for the supply and discharge of the hydraulic medium to the regulating cylinder (8) of the continuously variable transmission (1), and on the other hand, a control valve (15), whereby the valve bodies (16, 17) of the main valve (14) and the control valve (15) cooperate by means of elastic means, whereby the valve body (16) of the main valve (14) is loaded by a pressure regulated by the control valve (15) and whereby the valve body (17) of the control valve (15) is loaded by a pressure set by means of the above-mentioned control means.
2. Device according to claim 1, characterized in that the above-mentioned elastic means consist of a compression spring (18) between the valve body (17) of the control valve (15) and the valve body (16) of the main valve (14).
3. Device according to claim 2, characterized in that a room (19) has been provided at the valve body (17) of the control valve (15) which makes it possible to exert a force on said valve body (17) by means of a pressure which can be regulated by means of the above-mentioned control means, and in that at least one room (22; 44, 45) has been provided at the valve body (16) of the main valve (14) which makes it possible to exert a force on said valve body (16) by means of a pressure which can be regulated by the control valve (15).
4. Device according to claim 3, characterized in that a spring has been applied (21, 23) in both the control valve (15) and the main valve (14),

whereby both springs (21, 23) exert pressure forces on the respective valve bodies (17, 16), opposed to the force exerted by the above-mentioned compression spring (18).

5. Device according to claim 4, characterized in that the spring (23) exerting a force on the valve body (16) of the main valve (14) is opposed to the force exerted by the above-mentioned compression spring (18), supported by an element (42) which is coupled to any of the moveable pulley halves (5, 6) of the continuously variable transmission (1).
6. Device according to claim 5, characterized in that the above-mentioned element (42) is connected to the pulley half (5, 6) in question via a mechanical coupling.
7. Device according to claim 5 or 6, characterized in that two rooms (44, 45) have been provided at the valve body (16) of the main valve (14) which each make it possible to exert a force on said valve body (16) by means of a pressure, whereby in the normal working area the pressure in at least one of the two rooms (44, 45) is regulated by means of the control valve (15).
8. Device according to claim 7, characterized in that it has means which make it possible to automatically set the transmission ratio of the continuously variable transmission (1) at a fixed value when the control means fail.
9. Device according to claim 8, characterized in that the means which allow for the transmission ratio to be set at a fixed value consist of a switch valve (41) which makes it possible for one of the above-mentioned rooms (44, 45) of the control valve (15) of the controller (13) to be closed off when the control means fail, such that the effective surface of the valve body (16) of the main valve (14) upon which the pressure regulated by the control valve (15) acts is reduced.
10. Device according to claim 9, whereby control means have been applied of the type whereby in case of a failure a maximum control pressure is provided, characterized in that the switch valve (41) is loaded on the one hand by a spring (50) and on the other hand by a pressure in a room (51) connected to the room (19) of the control valve (15), in particular with the room (19) in which the pressure is regulated by means of the above-mentioned control means, whereby the valve body (49) of this

switch valve (41) is only moved against the force of the above-mentioned spring (50) when a certain pressure at the outlet of the control means is exceeded, and whereby a port (53) has been provided in the valve body (49) of this switch valve (41) which either connects one of the two above-mentioned rooms to a pipe (24) in which the pressure is regulated by the control valve (15), or closes this room (45) off of the control valve (15) and connects it to a discharge pipe (56), depending on whether or not the control means have failed.

11. Device according to claim 8, characterized in that the means which allow for the transmission ratio to be set at a fixed value consist of a switch valve (41) which makes it possible for one of the two above-mentioned rooms (44, 45) to be connected to a pipe (26) under constant pressure when the control means fail.
12. Device according to claim 11, whereby control means are used of the type whereby in case of a failure the outlet of these control means becomes pressureless, characterized in that the switch valve (41) is loaded on the one hand by a spring (50) and on the other hand by the pressure in a room (51) which is connected to the room (19) in which the pressure is regulated by means of the above-mentioned control means, whereby the valve body (49) of said switch valve (41) is moved against the force of the above-mentioned spring (50) when a certain pressure at the outlet of the control means is exceeded, and whereby a port (53) has been provided in the valve body (49) of this switch valve (41) which connects one of the two rooms (44, 45) to a pipe (26) under constant pressure as soon as the control means fail.
13. Device according to any of claims 3 to 12, characterized in that the control valve (15) has a port (25) which either supplies the hydraulic medium to the room (22) or to at least one of the two rooms (44, 45) of the main valve (14), or discharges the hydraulic medium from said rooms, depending on the pressure regulated by the control means.
14. Device according to claim 13, characterized in that the hydraulic medium is supplied to the valve body (17) of the control valve (15) by means of a pressure regulating valve (36).
15. Device according to any of the above claims, characterized in that the above-mentioned control means consist of a control valve (12) controlled by a control unit (39).

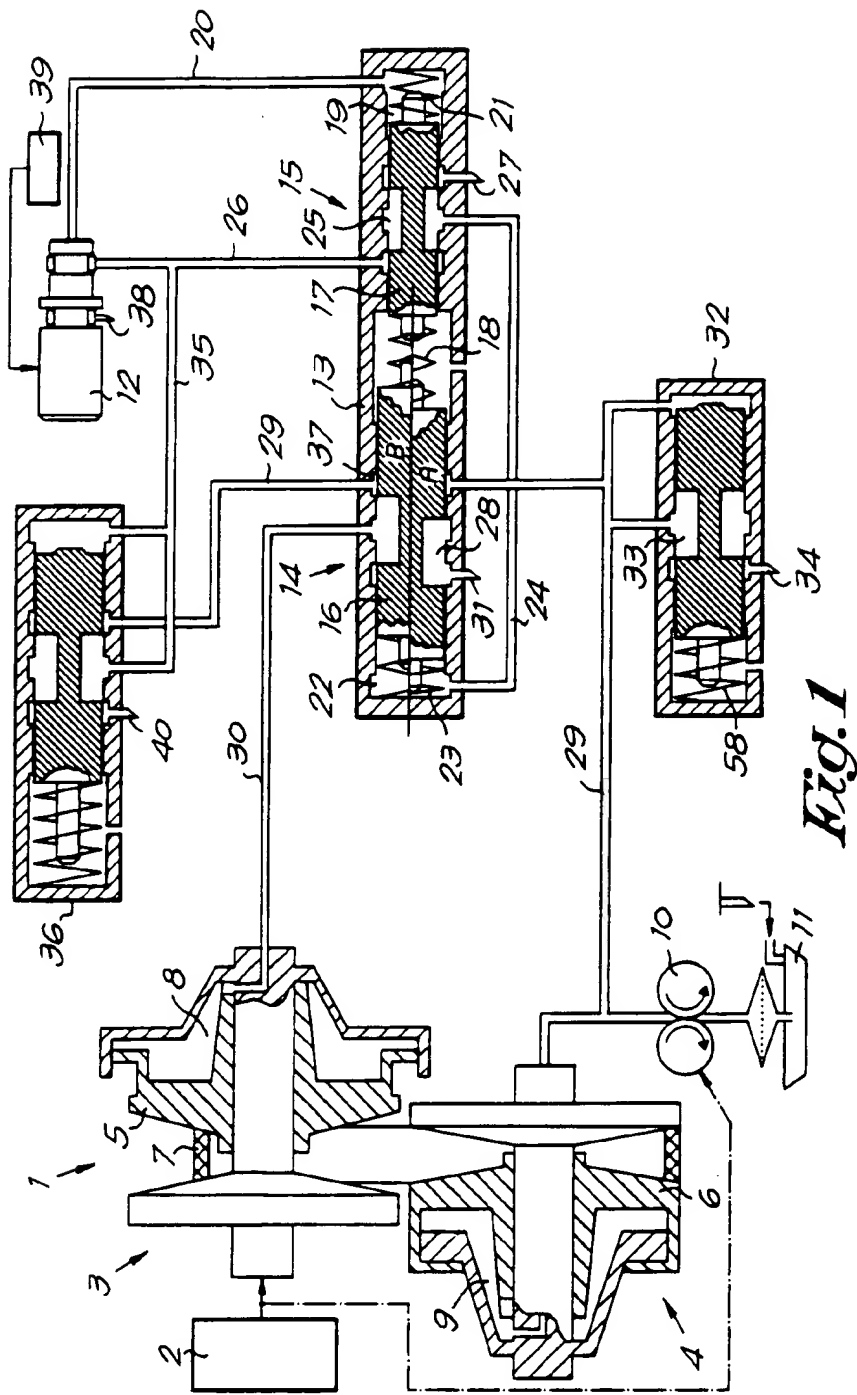
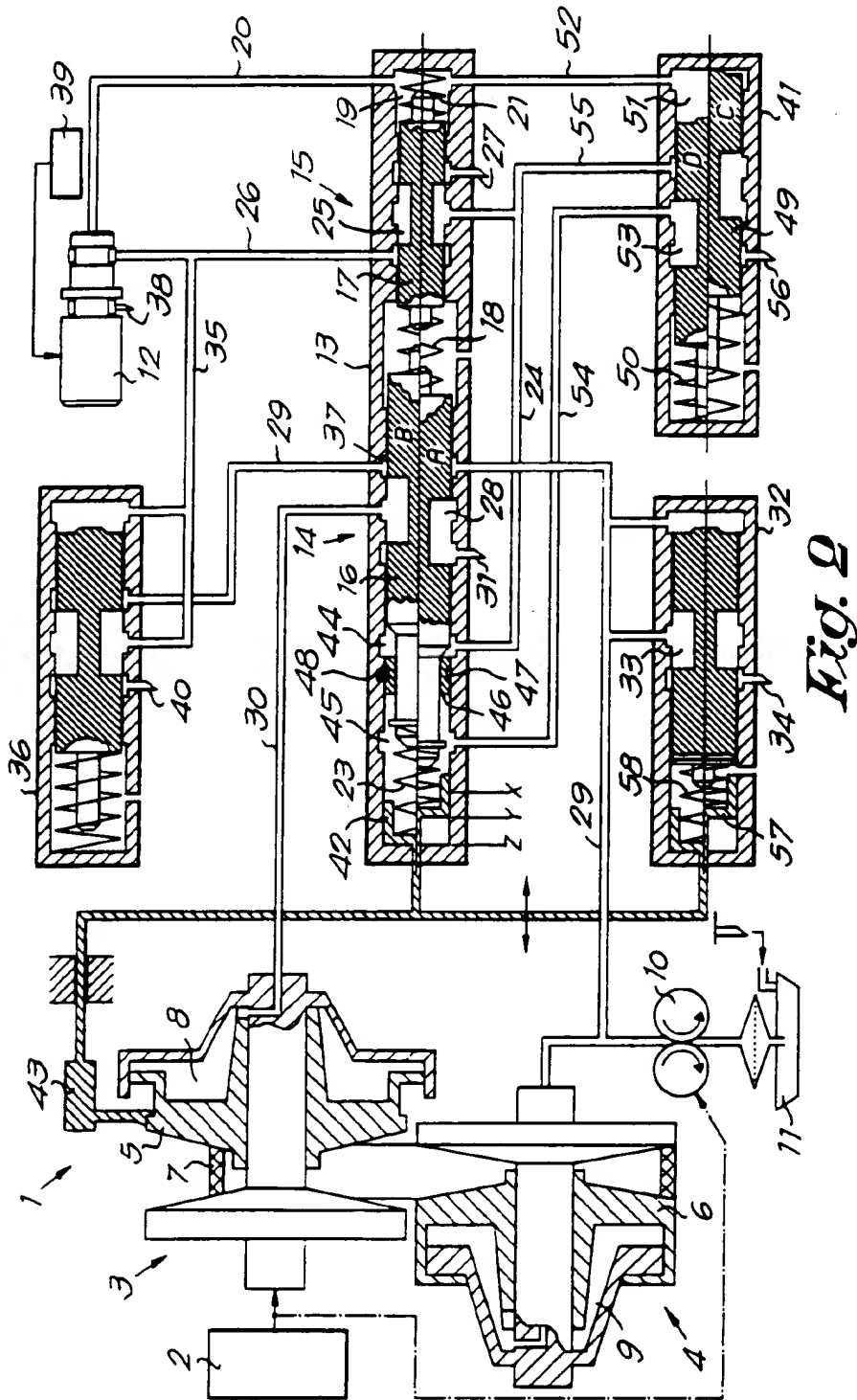
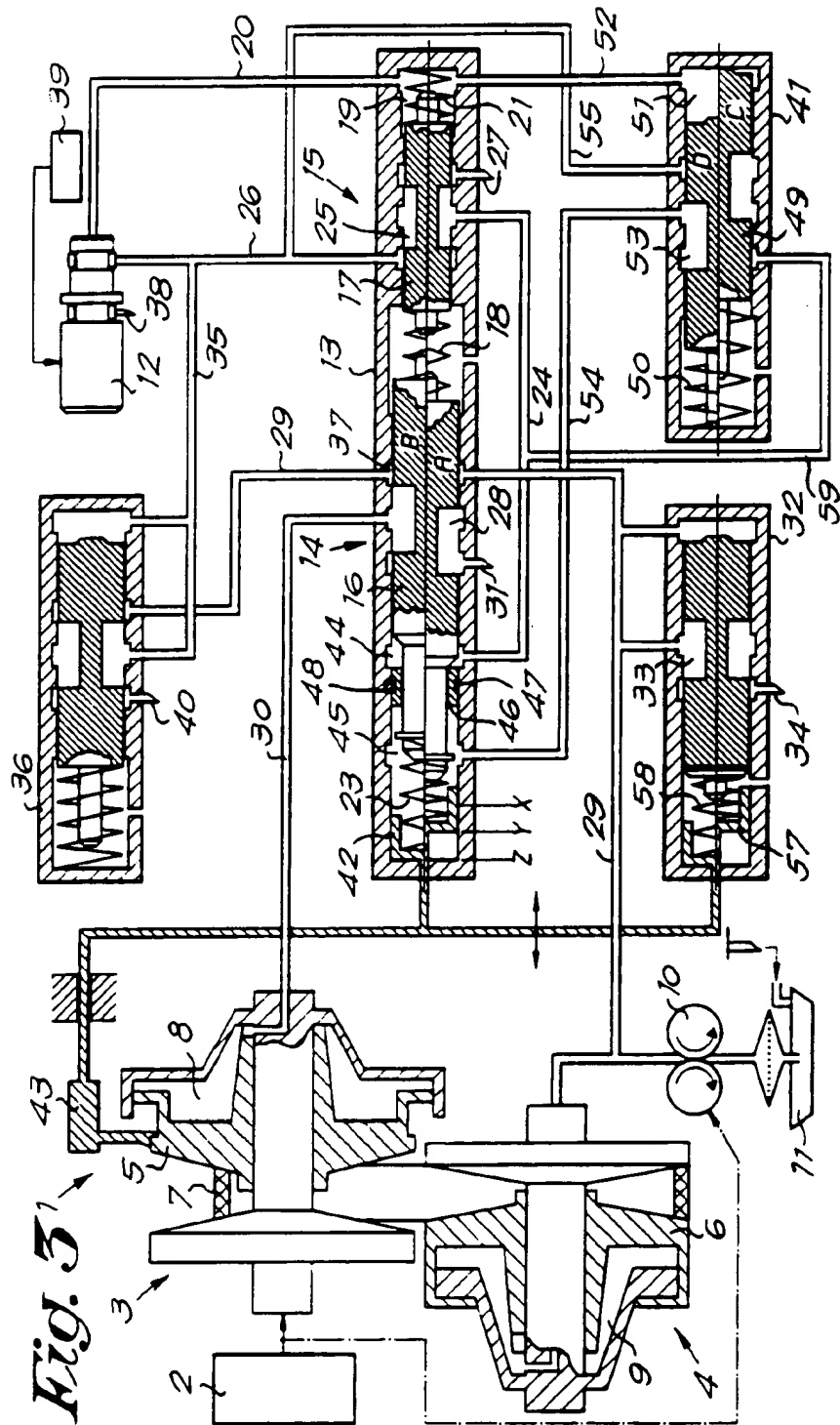


Fig. 1









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## EUROPEAN SEARCH REPORT

Application Number

EP 91 20 2919

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 237 (M-833)(3585) 5 June 1989 & JP-A-01 049 750 ( TOYOTA MOTOR CORPORATION ) 27 February 1989 * abstract *	1	F16H61/00 F16H61/12
A	DE-A-3 428 708 (MANNESMANN REXROTH GMBH) * abstract * * claim 1; figure 1 *	1,2	
A	EP-A-0 137 899 (FORD) * claim 1; figure 1 *	1,2	
A	EP-A-0 027 672 (VAN DOORNE'S TRANSMISSIE BV) * page 5, line 8 - page 8, line 26 * * figure 1 *	1,5,6	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F16H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 10 FEBRUARY 1992	Examiner VAN PROOIJEN T.
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